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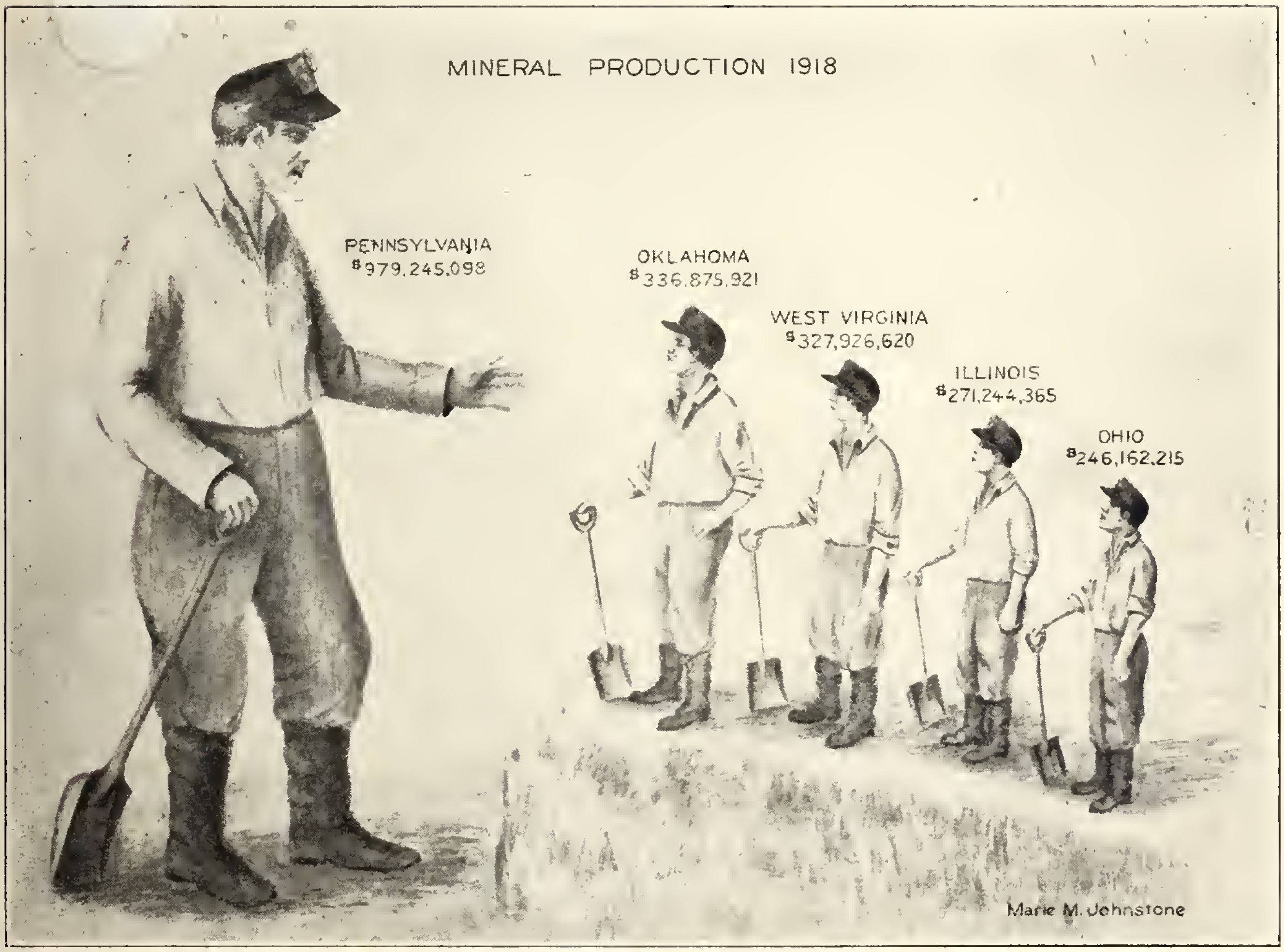
THE WORK OF
THE PENNSYLVANIA SURVEY
1919---1922

By George H. Ashley



PENNSYLVANIA, THE TITAN.

Pennsylvania digs out of the earth each year more mineral wealth than her three strongest rivals put together.

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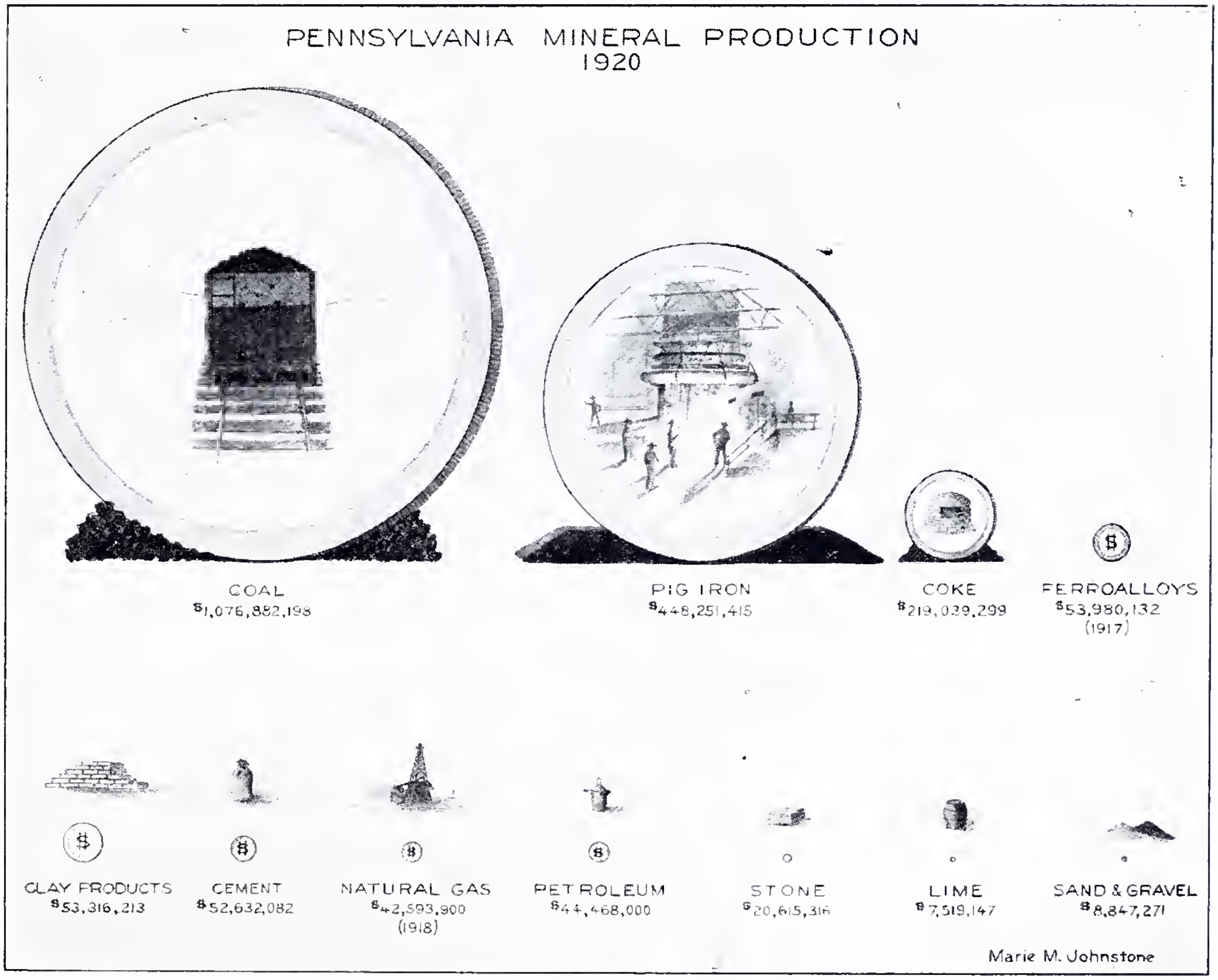
THE PENNSYLVANIA SURVEY

1919---1922

BY GEORGE H. ASHLEY



Pennsylvania leads the country in the production of coal, pig iron, lime, coke, ferroalloys, raw clay, cement, stone, natural gas, sand and gravel, and slate.

DEPARTMENT OF INTERNAL AFFAIRS
James F. Woodward, Secretary

BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
George H. Ashley, State Geologist
HARRISBURG

1923

THE WORK OF
THE PENNSYLVANIA GEOLOGICAL SURVEY

By GEORGE H. ASHLEY, State Geologist.

Introduction.

The value of goods and materials produced in Pennsylvania in 1920 was more than 11 billion dollars. Two-thirds of this value was based on minerals, and of these minerals, 1⅓ billion dollars worth came from mines, quarries, and wells within the State.

The value of Pennsylvania's output of raw minerals in 1920 was more than three times the value of the mineral production of any other State, greater than that of all the so-called mineral States of the Rocky Mountains and Pacific Coast region, including Alaska, and four times greater than the value of agricultural products in Pennsylvania. Back of the mining industries of Pennsylvania is the Pennsylvania Geological Survey.

There are several reasons why any State, particularly one that is a large producer of minerals, must have a State Geological Survey. This is a day of big business involving big investments. Every business is faced with uncertainties—in the market demands, in management, in the supply of raw materials—yet few lines of industry face so large an element of uncertainty as that of mining, quarrying, and drilling for oil, gas or water. No one can see underground. The best that can be done is to make a most careful survey of what is exposed on the surface, and supplement that with prospect drilling, and then interpret the results in the light of mining experience the world over. Such a survey to be effective must commonly cover whole districts, possibly thousands of square miles, in order to obtain the data necessary for the accurate determination of the underground conditions demanded by present-day business. Such a survey is out of the question for all but the very largest corporations and for every corporation to make such a survey for itself would involve endless repetition and waste of money. Hence arises the demand for a single comprehensive survey that shall be official, accurate, and its results open to everyone.

To meet this demand there has come about in recent years a great change in the methods of doing geologic work. It is no longer sufficient to get general results if more accurate results are possible. So long as oil drilling was confined to a depth of a few hundred feet and a hole cost only a few hundred dollars it did not matter much; but when the drill starts downward for a sand estimated to be 7,000 feet below the surface and at an estimated cost of one hundred thousand dollars or more, business wants the "guess' taken out of "guestimate." The geologist of today must therefore be an engineer as well as a geologist. He must be as familiar with the slide rule and cross-section paper as is the bridge engineer. It is because of the engineering character of present day geologic work that the State Geologist in the winter of 1919-1920 was able to predict in such marvelous fashion the course and final outcome of the McKeesport gas pool.

The work of the Pennsylvania Topographic and Geological Survey during the past three and one-half years has ranged from newspaper warnings against unprofitable investments in mining enterprises, particularly in oil and gas (warnings that are known to have saved the citizens of the State millions of dollars), to extending the topographic mapping of the State over several thousand square miles; from locating suitable stone for road building for the State Highway Department to identifying hundreds of specimens brought or sent to the office of the Survey; from the issuance of over fifty-seven varieties of bulletins to the answering of 6,000 written inquiries and 1,000 or more personal inquiries a year; from making preliminary surveys and preparing reports upon the oil and gas fields, coal, iron, limestone, and ganister deposits of the State, to detailed geologic mapping covering several thousand square miles; from cooperative service to most of the State departments amounting to several thousand dollars as measured in salaries for time required, to the accumulation and systematic filing of thousands of drill records, mine maps and other maps ready for instant, present or future use; from the distribution of thousands of reports and bulletins to advising many municipalities especially regarding water supply; from scores of lectures in many cities of the State on its mineral resources, geology, and physical features to many special papers for the technical and scientific journals.

The Survey was established by Act of Assembly signed June 7, 1919. It was planned from the beginning that this should be a "real Survey," to start with a nominal appropriation and build up until it was worthy of the major part played by the mineral industry of the State. Because of the anticipated loss of time in organizing the work, only $100,000 was appropriated for the first two years, 1919-1921. The whole summer was devoted to a canvass of the eligible geologists. The present State Geologist was appointed August 28, 1919, severed his connections with the Federal Survey, moved to Harrisburg, and was at work four days later. As the field season was then well over, only a small amount of outdoor work was undertaken that fall. Three field parties were organized and made an intensive study of the Vanport limestone to find suitable quarry sites for the Highway Department as just at that time a proposed embargo on hauling stone by the railroad companies threatened to shut off the supply of stone for the department in western Pennsylvania.

A cooperative agreement with the topographic branch of the United States Geological Survey was immediately entered into, resulting in the completion of the mapping of the Meyersdale quadrangle, and good progress on the Confluence quadrangle. As a result of this condition only one-fourth of the total appropriation was expended in the first year of the biennial period. That left $75,000 for the work in 1920, which allowed the program to go forward on a less restricted scale.

For the work of the years 1921-1923 a budget of $340,000 was approved by the Secretary of Internal Affairs and the Governor in accordance with plans made when the Survey was organized. The anticipated decline in the State's income led the Legislature to reduce that budget to $200,000, and later this appropriation shared in the general cut made necessary in order to bring the State appropriation within the estimated income. This cut reduced the money available to $150,000. In the first biennial period one-half of the funds was devoted to the topographic work. It had been hoped to expand that work in 1921, but the reduced appropriation prevented such expansion. However, to complete the work initiated in 1920 and to meet demands and opportunities arising in 1921 the work of that year was carried along on about the same scale as the year before, and along the same lines. This resulted in expending over $84,000 in 1921, leaving less than $66,000 for the last half of the biennial period. Consequently, although topographic work was maintained on the same scale as before, it became necessary to stop much geologic work already in progress (such as the coal sampling), and to postpone needed new work until the next appropriation should become available.

As the work of this Bureau is planned there are just so many square miles of the State to be surveyed, both topographically and geologically, at a definitely estimated cost. The rate at which the work can be carried on and the time in which it can be completed depends, therefore, on the size of the biennial appropriations. The value of such surveys, of course, depends on the accomplished results being available when needed. The sooner such surveys are completed obviously the greater the value to the State, and the greater return for the money expended.

This report outlines very briefly the operations of the Survey during the three and one-half years of its existence, its organization, and how its money has been spent. The report will take up the various lines of work in the order shown on the organization chart. As will appear, work has been confined to only a few of the many lines of work outlined in the chart. This has been necessary in order to accomplish immediate results. The other lines of work will be taken up as more funds become available or as the work now in progress is completed.

Organization.

The first step in the organization of the Survey was the planning of work and securing of equipment. As the Survey started with nothing but credit, it was necessary to obtain desks, tables, files, book and map cases, cabinets and other furniture and supplies, and field outfits from geologic hammers to plane tables. The work was greatly handicapped by the slow or non-delivery of this equipment.

The organization of the present Survey is shown in Chart 1. This chart will serve as a table of contents for the report which follows.

Bureau of Topographic and Geological Survey
Organization Chart

Branches	Divisions	Sections	Duty or subject
General Operations	Administration	Administration	Organization Policies Methods Conferences Correspondence Project Plans Budget, Costs
		Accounts, Records and Files	Accounts Personnel Mail and Express Files and Indexes
		Equipment and Materials	Office Equipment Field Equipment Supplies
	Information Service	Library and Collections	Books, etc. Maps Information Files Photos, Lantern Slides Mineral Collections
		Office Service	Correspondence Office Calls
		Outside Service	Lectures Articles Press Bulletins
		Cooperative Service	State Departments Federal Departments Other Organizations

Organization Chart—(Continued.)

Branches	**Divisions**	**Sections**	Duty or subject
General Operations (cont.)	Publication	Texts	Mss. Preparation Editorial
		Illustrations	Maps Diagrams & Sections Photos prepared Misc. Drawings
		Printing	By Printing Board By outside contract By office (Mimeograph)
		Distribution	Mail In person
Topographic Surveys	(In cooperation with) Atlantic division of the Topographic branch of the U. S. Geological Survey	Topographic work in Pennsylvania	Primary triangulation
			Primary control
			Secondary control & map sketching
Areal Geologic Surveys and General Studies	Detailed Surveys (Atlas)	Western and Northern Middle Belt Southeastern	
	County Surveys (County Reports)	Western and Northern Middle Belt Southeastern	
	General Studies	Laboratories	Chemical Petrographic Photographic
		Physical Geology	Dynamic Geology Structural Geology
		Historical Geology	Paleogeography Paleontology Earth History
		Resource Studies	General & Misc.
		Educational Studies	Regional Studies Railroad and Highway Guides Geologic Text Book Mineralogic and mineral resource texts

Organization Chart—(Continued).

Branch	Division	Section	Duty or subject
Mineral Resources	Fuels	Anthracite	
		Bituminous Coal	Peat
		Oil and Gas	Oil Shale
	Non-Metals	Clay and Clay Products	Clay, Shale
		Sand and Sandstone	Sand and Gravel Sandstone Ganister Silica
		Limestone	Limestone, Dolomite Lime, Cement, Marble, Marl
		Igneous and Metamorphic Rocks	Granite, Gneiss, Schists Trap, etc. Serpentine, Talc, etc. Slate
		Non-metallic Minerals	Salts & Fertilizers Graphite, etc. Feldspar
	Metals	Iron	Pigments, etc.
		Non-Ferrous Metals	Rare and Precious Metals Copper, Lead, Radium, etc.
	Soils		
	Water Resources		

ADMINISTRATION.

Policies: The policies of the Survey may be summed up in a few words, as follows:

(1) All work to be as high grade as that done by any similar organization in the world—or better.

(2) Definite plans covering the whole project, as far as it can be foreseen, to be made before field work is begun.

(3) Duplication of work to be avoided as far as possible. Cooperation to be entered into with other organizations equipped to do, or already doing satisfactorily, any work within the province of the Survey, in order to save the costs of equipment and operation.

(4) In supplying information or in the preparation of reports every effort to be made to realize the inquirer's actual need and point of view.

(5) While zealously guarding strictly confidential information, and making sure no information is given out that might in any way be used to the unfair disadvantage of those not having such information, the Survey will endeavor to make its findings quickly and readily available to the citizens of the State.

(6) In determining priority of work a careful study to be made of the apparent relative and immediate demand for information in various lines, not overlooking anticipated future demands.

(7) To maintain a proper balance between the so-called "scientific" and "economic" sides of the work, remembering that **reliable** economic results must be based upon the application of strictly scientific principles.

(8) The Survey personnel must have no financial interest in any mineral rights within the State, and shall not execute any private surveys in the State.

(9) To make every member of the Survey a partner in the common service, sharing in its plans and in its credit for work done.

Methods: The Survey has followed the best methods known to the geological profession and has not hesitated to try out suggested improvements of methods. A saving of $23,000 in 1921 in the cost of primary topographic control is one result of such an improvement, tested out on a small scale in 1920. (See Cooperation.)

Conferences: The Survey believes that two heads are better than one. It has therefore asked the advice and help of other engineers and geologists in making its plans. The State Geologist and other members of the Survey have attended many conferences in Pittsburgh, Philadelphia, Wilkes-Barre, Washington and elsewhere, at which matters affecting the Survey's work were under discussion. Frequent conferences are held in the office to get the best thought of the Survey personnel. In certain difficult, highly technical problems, the Survey has consulted specialists.

Administrative Correspondence: This includes the official correspondence between the office and men in the field, and that relating to supplies or other business originating in the Survey.

Project Plans and Budget: Preliminary to planning the work of the present Survey a careful review was made of work done by previous Surveys, the accessibility of reports of the earlier Surveys, and the quantity and status of unpublished work.

There have been three previous official State Geological Surveys: (1) The Geological Survey of Pennsylvania, H. D. Rogers, State Geologist, 1836-1841, roughed out the geology of the State, laying the foundation for later work. Small appropriations, but excellent work, reports mainly of historic interest today. (2) Second Geological Survey of Pennsylvania, J. P. Lesley, State Geologist, 1874-1887. Relatively large appropriations, excellent results achieved; 112 volumes published, covering about 12 feet of shelf. These volumes are still of great value and much sought but the official supply has long been exhausted. They can be obtained today only from dealers in secondhand books. This work, while excellent for its day, was hampered by lack of adequate base maps, and was done before many of the mineral areas known today had been prospected. It is therefore inadequate for present needs. (3) The Topographic and Geological Survey Commission was established in 1899. This Commission entered into cooperative agreements with the U. S. Geological Survey, and expended about three-fourths of the available fund for topographic mapping and one-fourth for geologic mapping. Under the cooperative agreement topographic mapping covered a large area in western and central Pennsylvania. The U. S. Geological Survey had previously mapped a large area in eastern Pennsylvania. Detailed geologic maps and reports in the form of "folios" and "bulletins" had been prepared and published by the Federal Survey (in addition to several folios published without cooperation).

In 1908 the Legislature provided for a State Geologist under the supervision of the Commission. Mr. Richard R. Hice occupied the position from 1908 to 1919. Cooperation with the U. S. Geological Survey continued in topographic mapping but not in detailed geologic work. Mr. Hice directed the preparation and publication of several reports on mineral deposits by various geologists. The Topographic and Geological Survey Commission was abolished by the act creating the present Survey.

The status of topographic and geologic mapping on September 1, 1919, expressed in square miles and percentages of the whole State (44,832 square miles) was as follows:

	Square miles	Per cent of State
Topographic maps published	25,100	56
Area unsurveyed	19,732	44
	44,832	100
Geologic maps published (under cooperation)	6,075	13
Geologic maps published (U. S. G. S. only)	1,350	3
Geologic maps made but unpublished	6,300	14
Total geologic maps	13,725	30.6
Total unmapped	31,107	69.4
	44,832	100.0

There are 144 topographic maps, each representing a quadrangle of about 225 square miles, approximately 17½ miles long from north to south and 13½ miles wide from east to west, or 15 minutes of latitude and of longitude.

The results of the geologic work have been published in 24 folios, each covering one or more quadrangles, and in 11 bulletins. All but six of the folios are out of print. The bulletins can be obtained from the Superintendent of Documents, Washington, D. C.

Plans. It was decided that the two principal jobs of the new Survey were the completion of the topographic and detailed geologic surveys of the State. The cost of completing the topographic work was estimated at approximately $600,000, of which it was assumed the U. S. Geological Survey would contribute one-half (as under present agreement). The cost of completing the detailed geologic surveys was estimated at about $1,000,000, in the cost of which it is hoped the Federal Survey will share.

Although the detailed geologic mapping forms the basis for all the detailed economic reports of the Survey, it was recognized that many of the demands on the Survey would be for information on a specific mineral rather than on the various minerals in a small area. A comprehensive series of reports on the various mineral resources of the State is therefore planned, including an introductory volume on each resource, to serve in answering inquiries until the detailed volumes can be prepared.

Individual county reports are planned also. These will be written in non-technical language and will include a soil map and many matters of general interest not covered in the other reports.

Budget. The estimated cost of this work is as follows:

Topography (one-half of $600,000)		$300,000
Explanatory text for Topographic Atlas		25,000
Geology:		
General	$300,000	
Mineral Resources	150,000	
Detailed Surveys	1,000,000	
County Reports	100,000	
		1,550,000
General Operations ($30,000 a year for 10 years)		300,000
		$2,175,000
Publication of Maps and Reports (to Printing Board)		700,000
Grand Total		$2,875,000

Accounts. Record has been kept of all expenditures in order that the State Geologist might know at any time the condition of the Survey's account, and keep in close touch with the cost of various projects and kinds of work.

This has made it possible to avoid a deficit, and to determine at any time whether or not emergency work could be undertaken.

Financial Statement.	June 7, 1919, to May 31, 1921.		June 1, 1921, to December 31, 1922.	
General Operations:				
Administration:				
Administration,	$6,653.25		$6,496.03	
Accounts and Records,	442.00		777.25	
Equipment and Material,	1,599.29		2,169.77	
	$8,694.54		$9,443.05	
Information Service:				
Library and Collections,	$261.00		$1,175.79	
Office Service,	7,900.00		6,955.81	
Outside Service,	1,558.40		1,253.46	
Cooperative Service,	3,410,85		1,026,65	
	$13,130.25		$10,411.70	
Publications:				
Texts,	$1,552,50		$4,480.27	
Illustrations,	5,039.23		6,151.41	
Distribution,	200.00		818.03	
Printing—(Mimeograph),	------------		1,787.37	
	$6,791.73	$28,616.52	$13,237.08	$33,091.83
Topographic Surveys:		$47,998.27		$40,193.30
Areal Surveys:				
Detailed Surveys:				
Honeybrook,	$10.00		------------	
McCalls Ferry,	2,579.59		2,662.32	
Meyersdale,	------------		889.09	
New Castle,	916.19		------------	
New Cumberland,	1,101.18		1,457.95	
New Kensington,	598.75		1,792.51	
Pittsburgh-Greensburg,	2,766.73		9,590.56	
Reading,	252.20		------------	
	$8,224.64		$16,392.43	
County Reports:				
Adams County,	------------		$322.08	
Greene County,	------------		386.56	
			$708.64	
General Geology:				
General Geology,	$1,579.27		$3,412.06	
Special Field Studies,	------------		1,633.69	
	$1,579.27	$9,803.91	$5,045.75	$22,146.82
Mineral Resources:				
Fuels:				
Coal,	$2,080.24		$10,363.44	
Oil and Gas,	6,081.52		1,043.61	
Oil Shales,	2,215.97		2,003.85	
	$10,377.73		$13,410.90	
Non Metals:				
Sand & Sandstone,	$793.30		$2,058.23	
Limestone,	449.45		2,416.42	
Potash,	100.86		------------	
Dolomites,	10.00		------------	
Non-metals Report,	------------		294.16	
	$1,353.61		$4,768.81	
Metals:				
Iron,	$1,827.88		$6,991.48	
Pigments,	10.00		------------	
Lead and Zinc,	------------		30.00	
	$1,837.88	$13,569.22	$7,021.48	$25,201.10
Soils: (See County Reports)				
Water Resources: (See Cooperative Service)				
Total,		$99,987.92		$120,633.14
Unexpended Balance, to June 1, 1921,		12.08	(Jan 1, 1923)	$29,366.86
		$100,000.00		$150,000.00

Financial Statement.	June 7, 1919, to May 31, 1921.		June 1, 1921, to December 31, 1922.	
Salaries:				
Field,	$32,446.63		$42,425.93	
Office,	39,169.08		49,711.87	
		$71,615.71		$92,137.80
Traveling-mainly surveying:				
Railroad,	$1,456.37		$1,773.83	
Hotel,	18,671.13		15,503.85	
Sundries,	410.85		456.92	
Automobile,	5,537.64		7,216.75	
Hired Vehicles,	53.79		16.02	
		$26,129.78		$24,967.37
Office Expenses:				
Am. Ry. Express,	$9.90		$77.21	
Telep. & Teleg.,	50.17		151.98	
Postage,	10.08		10.63	
Beaver office rent,	62.50	Motor Car Storage	184.30	
		$132.65		$424.12
Sundry Office Equipment and Furniture:	$2,109.78	$2,109.78	$3,103.85	$3,103.85
Total,		$99,987.92	Total	$120,633.14
Unexpended Balance,		12.08	Balance on hand Jan. 1, 1923	29,366.86
		$100,000.00		$150,000.00

Personnel: The personnel consists of geologists, engineers, illustrators and clerical staff continuously employed in the office in the State Capitol at Harrisburg, teachers and students of geology and other sciences employed temporarily, and topographic engineers of the U. S. Geological Survey with their numerous field assistants. The accompanying list shows the personnel of the Harrisburg office force from September 1, 1919, to December 31, 1922, the character of employment in each case, and in a general way the time of service of each member. The personnel consists of a small group of geologists and engineers, draftsmen, clerks and office assistants holding regular appointment and giving their whole time to the work of the Survey.

Office Staff:

George H. Ashley,	(Sept. 1919)	State Geologist
Ralph W. Stone,	(Jan. 1922)	Asst. State Geologist
J. French Robinson,	(Resigned Mar. 15, 1921)	Associate Geologist
J. Ross Corbin,	(Dec. 1920)	Associate Geologist
John F. Reese,	(Nov. 1921—July 1922)	Associate Engineer
Dr. Anna I. Jonas,	(Sept. 1919)	Assistant Geologist
J. D. Sisler,	(Dec. 1920)	Assistant Geologist
Meredith E. Johnson,	(Feb. 1921)	Assistant Geologist
Roland W. Brown,	(Resigned Sept. 15, 1920)	Geologic Aid
Charles K. Graeber,	(July 1921—May 1922)	Geologic Aid
C. W. Webbert,	(Resigned May 1, 1920)	Clerk
O. P. Solem,	(Resigned July 1, 1922)	Draftsman
John G. Hanford,	(Resigned October 1, 1921)	Draftsman
Marie M. Johnstone,	(Oct. 1921)	Draftsman
Emily P. Flynn,	(Sept. 1922)	Draftsman
Lizette F. Carey,	(Sept. 1919)	Executive Assistant
Jean N. Rauch,	(Resigned July 1, 1921)	Stenographer
Elizabeth B. Garner,	(May 1920)	Stenographer
Anna C. Bock,	(Jan. 1922)	Stenographer
Elinor M. Bierstein,	(Feb. 1922—June 1922)	Stenographer
R. Frank Shaffner, Jr.	(Aug. 1921)	Office Assistant
Charles O. Milnor,	(March 1922—April 1922)	Office Assistant
John McCulloch,	(April 1922—June 1922)	Office Assistant
John D. Martin,	(Feb. 1921—May 1921)	Office Assistant
A. E. Fitzimons,	(Sept.-Oct. 1920)	Office Assistant
Marchant N. Shaffner,	(Sept. 1922)	Office Assistant
Harrison C. Allaman,	(Jan. 1923)	Office Assistant

The Survey enjoys the service of a large group of cooperating geologists, most of whom occupy teaching positions in the State. They work at a moderate salary during their vacation periods. In many instances the task assigned was work upon which they had already accumulated a large amount of data, of which the Survey secured the benefit. The cooperating geologists are paid only for the days they work for the Survey, with expenses while in the field.

Cooperating Geologists:

Dr. F. Bascom, Bryn Mawr College, Bryn Mawr, Pa.
Prof. Olin G. Bell, Cornell University, Ithaca, N. Y.
Dr. M. H. Bissell, Bryn Mawr College, Bryn Mawr, Pa.
Prof. C. A. Bonine, State College, State College, Pa.
Mr. Robert B. Bossler, University of Pittsburgh, Pittsburgh, Pa.
Dr. Harry N. Eaton, Syracuse University, Syracuse, N. Y.
Dr. H. L. Fairchild, University of Rochester, Rochester, N. Y.
Prof. Charles R. Fettke, Carnegie Institute of Technology, Pittsburgh, Pa.
Mr. Lloyd C. Fenstermacher, U. S. Geological Survey, Washington, D. C.
Prof. A. H. Fretz, Lehigh University, Bethlehem, Pa.
Prof. George N. C. Henschen, Harrisburg High School, Harrisburg, Pa.
Mr. Richard R. Hice, Beaver, Pa.
Prof. Erle G. Hill, University of Pittsburgh, Pittsburgh, Pa.
Mr. Kent K. Kimball, U. S. Geological Survey, Washington, D. C.
Mr. Charles Lawall, Lehigh University, Bethlehem, Pa.
Prof. Fred G. Merkle, State College, State College, Pa.
Dr. Benjamin L. Miller, Lehigh University, Bethlehem, Pa.
Dr. E. S. Moore, State College, State College, Pa.
Prof. Austin L. Patrick, State College, State College, Pa.
Prof. Frederick Peck, Lafayette College, Easton, Pa.
Dr. W. Armstrong Price, Johns Hopkins University, Baltimore, Md.
Dr. George B. Richardson, U. S. Geological Survey, Washington, D. C.
Prof. C. W. Robinson, State College, State College, Pa.
Prof. H. Justin Roddy, State Normal School, Millersville, Pa.
Mr. Chester K. Wentworth, U. S. Geological Survey, Washington, D. C.
Dr. Edgar T. Wherry, U. S. Dept. of Agriculture, Washington, D. C.
Captain C. H. Zierdt, State College, State College, Pa

Another group consists of field men, holding only temporary appointments on a per diem basis employed during vacations. Practically all of them are graduate students, teaching fellows, or professors of geology, and many of them have been employed upon problems with which they were already quite familiar, so that the Survey benefited by their previous experience.

Geologic Aids:

C. J. Campbell, State College, State College, Pa.
W. A. Copeland, Carnegie Institute of Technology, Pittsburgh, Pa.
L. A. Faustino, U. S. Geological Survey, Washington, D. C.
Lloyd W. Fisher, Lehigh University, Bethlehem, Pa.
Louis P. Foley, Connellsville, Pa.
Richard P. Howell, Devon, Pa.
C. O. Kingsbury, Pittsburgh, Pa.
R. B. Paxson, Lancaster, Pa.
B. Coleman Renick, University of Chicago, Chicago, Ill.
P. S. Schoeneck, University of Pittsburgh, Pittsburgh, Pa.
Thomas G. Taylor, State College, State College, Pa.
C. O. Webb, Wellsboro, Pa.
L. D. Woodworth, Carnegie Institute of Technology, Pittsburgh, Pa.

The topographic force has consisted of a small group of topographic engineers holding Civil Service appointment under the Federal Survey and a much larger group of temporary assistants, employed only during the field season. As a rule the temporary employes of the topographic branch were employed at $2.00 a day with a per diem of $2.00 in lieu of subsistence.

Topography:

Frank Sutton, Geographer in Charge

Topographic Engineers:

R. G. Clinite	1921-22
A. T. Fowler	1921-22
C. C. Gardner	1920-21-22
J. Irving Gayetty	1920-21
Duncan Hannegan	1920-21-22
R. L. Harrison	1921
Oscar Jones	1920-21-22
J. L. Lewis	1920
J. F. McBeth	1920-21-22
Robert Muldrow	1920-21-22
Albert Pike	1922

Assistant Topographic Engineers:

Max Gleissner	1920
E. B. Hill	1922
J. C. Hilliard	1920
A. J. Kavanaugh	1920
R. L. McCammon	1921
F. J. McMaugh	1921
S. L. Parker	1920-21
C. E. Reick	1921
M. A. Roudabush	1920-21
H. E. Simmons	1920
H. B. Smith	1922
G. B. Wilson	1922

Junior Topographic Engineers:

W. E. Baird	1920-21-22
W. S. Beames	1920
W. R. Chenoweth	1921
G. S. Druhot	1921
Kostka Mudd	1921
Frank M. Schilling	1920
G. E. Sisson	1921
R. F. Wilcoxon	1921

Field Assistants:

L. O. Canter	1920
W. F. Chenault	1920
C. R. deMedicis	1920
Walter McCrea	1920-21-22

Computer:

J. L. Lenovitz	1920-21

Rodmen:

Boyd Baker	1920-21
O. C. Barry	1922
L. M. Bowman	1922
H. P. Breese	1920
H. L. Budinger	1921
J. M. Burritt	1921
J. J. Caille	1920
A. A. Carney	1920
E. D. Chamberlain	1920-21
George C. Chenault	1921
R. R. Chenault	1920-21
P. H. Clark	1920
A. B. Claxton	1920
A. B. Coulter	1922
Philip Croyle	1920
Matt Daura	1920-21
Wm. A. Dickson	1920-21
C. C. Dulany	1921
H. C. Dulany	1921
Chas. G. Dunn	1920
Walter Dutner	1922
E. T. Greenstreet	1920
Bert Griffith	1920
N. F. Hampton	1921
E. A. Hannegan	1921
Pierce Hills	1920
Paul Hitchens	1922
J. T. Hoffman	1922
Robert Holden	1920
K. K. Hoyt	1922
M. A. Hufty	1920-21
Frank S. Jamison	1920
C. T. Johnson	1921
Frank M. Johnson	1921
Neilson Jones	1921
W. G. Kempner	1921
M. C. Kerr	1922
Palmer Kuhns	1920
Rufus H. Lane	1921
L. H. Lamar	1922
C. E. Lewis	1921
Samuel Lewis	1921
H. C. Loney	1920
F. H. McBeth	1920-21
David McCoy	1922
Robt. McCulloch	1920
John H. McLeister	1921
Robert Marvin	1920
S. H. Mitchell	1920-21
G. A. Mock	1920-22
Paul J. Parks	1921
Jos. E. Petrovitch	1921
R. Polmounter	1921
E. H. Proctor	1922
John Rathberger	1921

Martin Reitz	1921
J. G. Rivers	1920-21
J. B. Robinson	1922
G. C. Rothrock	1921
Mark Secrist	1920
Charles W. Smith	1920
Ernest Snyder	1920
J. L. Sothoron	1921
C. Y. Taylor	1921
Frank A. Taylor	1921
Nelson Thompson	1922
B. A. Trapin	1920
J. S. Ward	1920
Frank Warriner	1920
C. Y. Wheeler	1921
J. B. Whitman	1922
T. Wilson	1920
Roy Wiltse	1920
L. O. Wix	1922

Records and Files. The Survey has kept a complete daily record of mail and express matter handled. All correspondence and related matter have been filed by a recognized standard system.

Office and Field Equipment. The Bureau acquired its equipment by purchase and by the transfer of furniture discarded by other State bureaus. The Survev's need of filing facilities for specimens, maps, books and other material has become so urgent that the policy of taking over any adequate equipment in good condition abandoned by other Bureaus has been necessary in order to conserve funds for other productive uses.

INFORMATION SERVICE.

Library and Collections. Competent information service primarily depends upon the choice of personnel of the Survey. The State Geologist has been fortunate enough to assemble a force of geologists, each a specialist in a different branch of geology. Inquiries are referred directly to the geologist most familiar with the problem in question. However, it is impossible to answer all inquiries directly from memory. Therefore, to answer all inquiries adequately, and to gather together all available information, a complete information file, and access to books, maps and specimens is necessary. To this end a library has been collected and reference files filled with maps, specimens, photographs and many other types of information. The State Geologist placed in use his own geologic library of approximately 3000 volumes, and the other geologists in the Harrisburg office have about 1500 privately owned volumes in official use. Sets of maps, other reports and other information have been accumulated as fast as possible. Type collections of the rocks, fossils, and minerals of the State have been started by members of the Survey in connection with their studies. These different types of information are already so complete that the Survey has been designated by the Federal Board of Surveys and Maps as a reference point for this and surrounding States. Many photographs have been taken, the best ones being made into lantern slides for use in public lectures by Survey members.

Office Service. A large part of the Survey's work consists in answering inquiries, made either in person or by letter. During the past three and one-half years between 3000 and 4000 persons have called at the office for information. The following table shows the number of pieces of outgoing mail in three and one-half years:

Letters answered,	14,096
Circular letters,	6,441
Packages,	2,122
Mimeographed bulletins,	32,876
Miscellaneous paper No. 1,	6,000
Commission Survey Reports,	6,112
Oil-gas report, just issued,	420
	68,067

The Survey, if possible, answers written inquiries the same day they are received. The character of these inquiries is well illustrated in a list of one day's correspondence printed in Miscellaneous Papers No. 1 of the Survey. Many of these inquiries are of trivial nature, such as the identification of specimens of little or no value; others pertain to the expenditure of hundreds of thousands or millions of dollars.

No small part of the Survey's value to the public is to prevent the expenditure of money in developing supposed mineral deposits that geologic knowledge indicates are not commercially valuable. A few instances of this character were described in Miscellaneous Papers No. 1. Since that paper was published the number of such examples has so multiplied that it seems perfectly safe to say that information from this Survey has saved many million dollars of useless expenditure by citizens of the State.

The recent gas development in Clinton County has had the benefit of geologic advice from the Survey, including a number of conferences in the State Geologist's office.

Outside Service. In addition to the information given to callers and by correspondence, the State Geologist and other members of the Survey have delivered many public lectures. The State

Geologist has given talks in Philadelphia, Pittsburgh, Reading, Lancaster, Bethlehem, Lewisburg, State College, Easton, and elsewhere. The Survey has been so handicapped by the printing situation that is has resorted to writing articles for the technical and daily press to broadcast its information.

Cooperative Service. The policy of this Bureau has been to cooperate freely with other bureaus and departments of the Commonwealth, with the Federal Departments, and with other organizations.

The largest cooperative work is the topographic mapping of the State by the U. S. Geological Survey. When the present State Survey was organized 56 per cent. of pennsylvania had been surveyed topographically. A large part of this work had been done in cooperation with the Pennsylvania Topographic and Geological Survey Commission. The Federal Survey has maintained for many years a large, specially trained force of topographers, and has agreed to assume half the cost of the work. The State Survey therefore entered into an agreement whereby the Federal Survey would continue topographic work. The Federal Survey meets all expenses of engraving and printing the maps. Under this agreement 23 quadrangles, or about 5000 square miles, have been completely surveyed. Seven quadrangle maps have been finished for distribution and several others may be available soon after January 1, 1923. A small number of advance copies of quadrangles surveyed prior to 1923 are now available. The primary control has been completed on a large number of additional quadrangles. Within three years, primary control on all remaining quadrangles will probably be completed.

In cooperation with the State Highway Department in 1919, the Geological Survey had three parties in the western part of the State tracing the Vanport limestone to locate possible quarry sites. The quality and quantity of the limestone, quarrying conditions and transportation facilities at every possible quarry site were investigated and reported to the Highway Department. The Survey has helped the Highway Department to find stone for road building in other parts of the State as well. On the other hand, the State Highway Department has loaned its traverse notebooks to the topographic engineers, thus saving $22,700 in the cost of topographic mapping in 1921 and probably as much more in 1922.

Cooperation with the Pennsylvania Department of Mines has resulted in this Survey securing much valuable data from State mine inspectors on every mine coming under the State mine inspection law. Printed forms used by the Survey for the examination and sampling of mines have been filled out by the mine inspectors, giving this Survey and the Department of Mines the most complete information regarding the mines of the State that has ever been brought together.

The Survey has supplied the Attorney General with information required in the preparation of the anthracite tax cases; has reported to the Department of Health upon the possible source of contamination of springs and streams; cooperated with the Auditor General's Department in the study of coal land values for corporation taxation; with the Educational Department by writing articles for its publications and by supplying general information; and with the other departments of the State Government in many incidental ways.

Definite cooperation has been established with the U. S. Bureau of Mines, the U. S. Geological Survey, the U. S. Bureau of Soils, and incidentally with other Federal Departments.

The policy of the Pennsylvania Geological Survey is not to duplicate work being done satisfactorily by some other organization. In accordance with this policy the State Survey has not established an elaborate chemical and assaying laboratory. Chemical work is done through cooperation with the Pennsylvania Bureau of Chemistry, with the U. S. Bureau of Mines at its laboratory in Pittsburgh or with properly equipped laboratories in the universities of the State. A study of the quality of Pennsylvania coals was undertaken in cooperation with the U. S. Bureau of Mines. Messrs. Woodworth, Hill, and Sisler of the State Survey collected 755 samples from 271 mines, and the U. S. Bureau of Mines analyzed them.

The Survey has cooperated with municipalities and other public organizations in the study of water supply and other geological problems. Members of the Survey have made field examinations for Reading, Ephrata, Bedford and Bellefonte regarding their water supply and have advised regarding projects that would cost over a million dollars.

The Survey is cooperating with the American Foundrymen's Association in a study of molding sand, the Survey investigating the occurrence and distribution of molding sands, and the Association making laboratory tests.

The Survey has cooperated with many other organizations, including the Federal Board of Surveys and Maps, the National Research Council, and the Association of State Geologists. The Survey has given aid to the libraries of the State in completing their sets of geologic reports. The libraries in turn have been ready to offer their facilities to correspondents who have been referred to them for data in reports that have long been out of print.

PUBLICATIONS.

Since the organization of the Bureau, lack of funds and other conditions have resulted in less than 100 pages being printed for the Survey.

Because of the impossibility of getting reports printed, the Survey finally resorted to mimeograph bulletins to present some of the information gathered and to save writing long letters in reply to inquiries. Though his name does not appear on them, Mr. Stone, the Assistant State Geologist, has been responsible for editing all but two of the 61 bulletins listed below, for the partial rewriting of several, and for the complete preparation of several by abstracting from longer reports. The preparation, printing, and mailing of these mimeographed reports has taken no small part of the time of the technical and clerical staff of the office. Meantime, texts, illustrations and maps for a number of projects are in preparation or already completed.

List of Publications to December 31.

Reports.

The Story of the Survey, by George H. Ashley. An illustrated brochure of 20 pages, describing the history of official geologic work in Pennsylvania and the reasons for the present Survey and its proposed methods of work. (Misc. Papers, No. 1.)

The Oil and Gas Fields of Pennsylvania Vol. 1, Introduction. By George H. Ashley and J. French Robinson. A condensed, introductory description of the origin, mode of occurrence, and conditions of development of oil and gas, with a table and brief description of each of the oil and gas fields of the State; also a small scale map of the oil and gas fields. (79 pages).

Bulletins.

1. Effect of the War on the Price of Coal in Pennsylvania—by George H. Ashley—3 pages.
*2. Oil and Gas in Southeast Pennsylvania—by George H. Ashley—4 pages.
3. Development and Probable Life of Gas Pool at McKeesport, Pennsylvania—by George H. Ashley—3 pages.
4. Decline of McKeesport Gas Pool—by George H. Ashley—3 pages.
5. The McKeesport Gas Pool—by George H. Ashley—26 pages, 2 maps.
6. River and Creek Coal in Eastern Pennsylvania—by C. W. Webhert—17 pages.
7. A High-Grade Building Stone in Greene County—by George H. Ashley—2 pages.
8. The Origin of Pennsylvania Coal—by George H. Ashley—7 pages.
9. Future Use of Raw Coal—by George H. Ashley—5 pages.
*10. The Possibility of Oil and Gas From Deeper Drilling in Western Pennsylvania—by George H. Ashley—5 pages.
*11. Gas Wells on Nine Mile Run, Pittsburgh, Penna.—by J. French Robinson—2 pages.
*12. Gas Wells on Pollock Run, Westmoreland County, Pennsylvania—by J. French Robinson—2 pages.
*13. Natural Gas Situation in Pennsylvania—by George H. Ashley—3 pages.
14. Future Sources of Power—by George H. Ashley—3 pages.
15. Mineral Resources of Pennsylvania—by George H. Ashley—12 pages.
*16. Geology of Oil and Gas in Relation to Coal—by George H. Ashley—6 pages.
*17. Future of Natural Gas in Pennsylvania—by George H. Ashley—4 pages.
18. Oil from Pennsylvania Shales and Coals—by Chas. R. Fettke—15 pages.
19. Production of the McKeespert Gas Pool—by J. French Robinson—12 pages.
10 supplements, 15 pages, 2 charts, 1 map.
20. Pennsylvania Iron Ores—by J. Ross Corbin—3 pages.
21. Feldspar in Pennsylvania—by George H. Ashley—2 pages.
22. Coal Beds in Southern Somerset County, Pennsylvania—by J. D. Sisler—16 pages.
23. Coal Beds in Cambria County, Pennsylvania—by J. D. Sisler—13 pages.
24. Coal Beds in Greene County, Pennsylvania—by J. D. Sisler—6 pages.
25. Coal Reserves in Greene County, Pennsylvania—by John F. Reese—6 pages.
26. Coal Beds in Washington County, Pennsylvania—by J. D. Sisler—8 pages.
27. Coal Reserves in Washington County, Pennsylvania--by John F. Reese—6 pages.
28. Magnesite in Pennsylvania—by R. W. Stone—3 pages.
29. Geologic Structure of the Greensburg Quadrangle, Penna.—by M. E. Johnson—3 pages, 1 map.
30. Coal Beds in Allegheny County, Pennsylvania—by J. D. Sisler—9 pages.
31. Coal Reserves in Allegheny County, Pennsylvania—by John F. Reese—5 pages.
32. Coal Beds in Fayette County, Pennsylvania—by J. D. Sisler—13 pages.
33. Coal Reserves in Fayette County, Pennsylvania—by John F. Reese—5 pages.
34. Coal Beds in Westmoreland County—by J. D. Sisler—15 pages.
35. Coal Reserves in Westmoreland County, Pennsylvania—by John F. Reese—5 pages.
36. Coal Beds in Indiana County, Pennsylvania—by J. D. Sisler—11 pages.
37. Coal Reserves in Indiana County, Pennsylvania—by John F. Reese—5 pages.
38. Coal Beds in Armstrong County, Pennsylvania—by J. D. Sisler—12 pages.
39. Coal Reserves in Armstrong County, Pennsylvania—by John F. Reese—5 pages.
40. White Clay Deposits at Saylorsburg, Monroe County, Pennsylvania—by Frederick B. Peck—7 pages, 1 map.

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*The matter in these reportsis included in the report "Oil and Gas Fields of Pennsylvania" issued in December, 1922; therefore these reports have been discontinued.

41. Coal beds in Elk County, Pennsylvania—by J. D. Sisler—5 pages.
42. Coal Beds in Jefferson County, Pennsylvania—by J. D. Sisler—10 pages.
43. Coal Reserves in Somerset County, Pennsylvania—by John F. Reese—12 pages.
44. Coal Reserves in Cambria County, Pennsylvania—by John F. Reese—5 pages.
45. White Clay Deposits in Central Pennsylvania—by E. S. Moore—6 pages, 1 map.
46. Coal Beds in Butler County, Pennsylvania—by J. D. Sisler—5 pages.
47. Manganese Occurrences in Eastern Pennsylvania—by Benjamin L. Miller—11 pages.
48. Pyrite from Bituminous Coal Mines in Pennsylvania—by Henry Leighton—19 pages, 3 plates, 1 map.
49. Coal Beds in Clarion County, Pennsylvania—by J. D. Sisler—7 pages.
50. Coal Beds in Center, Cameron, Clinton and Lycoming Counties, Pennsylvania—by J. D. Sisler—8 pages.
51. New Oil Pool at Tidioute and Gas Pools Near Corry and Meadville, Pennsylvania—by M. E. Johnson—4 pages, 1 map.
52. Coal Beds in Mercer, Crawford, Venango, Forest, Warren, McKean, Potter, Tioga and Bradford Counties, Pennsylvania—by J. D. Sisler—10 pages.
53. Coal Reserves in Clearfield County, Pennsylvania—by John F. Reese—6 pages.
54. Bituminous Coal Reserves in Pennsylvania—by John F. Reese—9 pages.
55. Coal Beds in Lawrence County, Pennsylvania—by J. D. Sisler—3 pages.
56. Oil Fields Rejuvenated—by Robert B. Bossler—14 pages.
57. Coal Beds in Beaver County, Pennsylvania—by J. D. Sisler—4 pages.
58. Potash Fiasco in Tioga County, Pennsylvania—by R. W. Stone and Simple Tests for Potash by W. B. Hicks—7 pages.
59. Bog-Iron Ore—by J. Ross Corbin—5 pages.
60. Geologic Structure of the Pittsburgh Quadrangle, Penna. by M. E. Johnson—4 pages, 1 map.
61. Magnetite in Pennsylvania—by J. Ross Corbin—6 pages, 1 map, 1 chart.

The following bulletins are listed for issuance early in 1923:

62. Rocks of McCalls Ferry quadrangle, Penna.—by Dr. Anna I. Jonas—6 pages, map.
63. Brown Ores in Pennsylvania—by J. Ross Corbin.
Coal Beds of Clearfield County, Penna.—by George H. Ashley.
Ganister in Pennsylvania—by E. S. Moore.
Lead and Zinc Ores in Pennsylvania—by B. L. Miller.
Marl Deposits in Pennsylvania—by J. B. R. Dickey.
Hematite in Pennsylvania—by J. Ross Corbin.
Manganese in Pennsylvania—by J. Ross Corbin.
Gold and Silver in Pennsylvania—by J. Ross Corbin.
Vanadium, Uranium, and Radium in Pennsylvania—by J. Ross Corbin.
Copper and Nickel in Pennsylvania—by J. Ross Corbin.
Chromite and Tungsten in Pennsylvania—by J. Ross Corbin.
Limestone for Various Purposes—by B. L. Miller.
The Flagstone Industry in Northeastern Pennsylvania—by R. W. Stone.
The Roofing Granules Industry in Pennsylvania—by R. W. Stone.
The Flint Clays of Pennsylvania—by George H. Ashley.
Notes on Oil and Gas Development in Pennsylvania in 1922—by M. E. Johnson.
The Oil and Gas Sands of the Pittsburgh District—by M. E. Johnson.

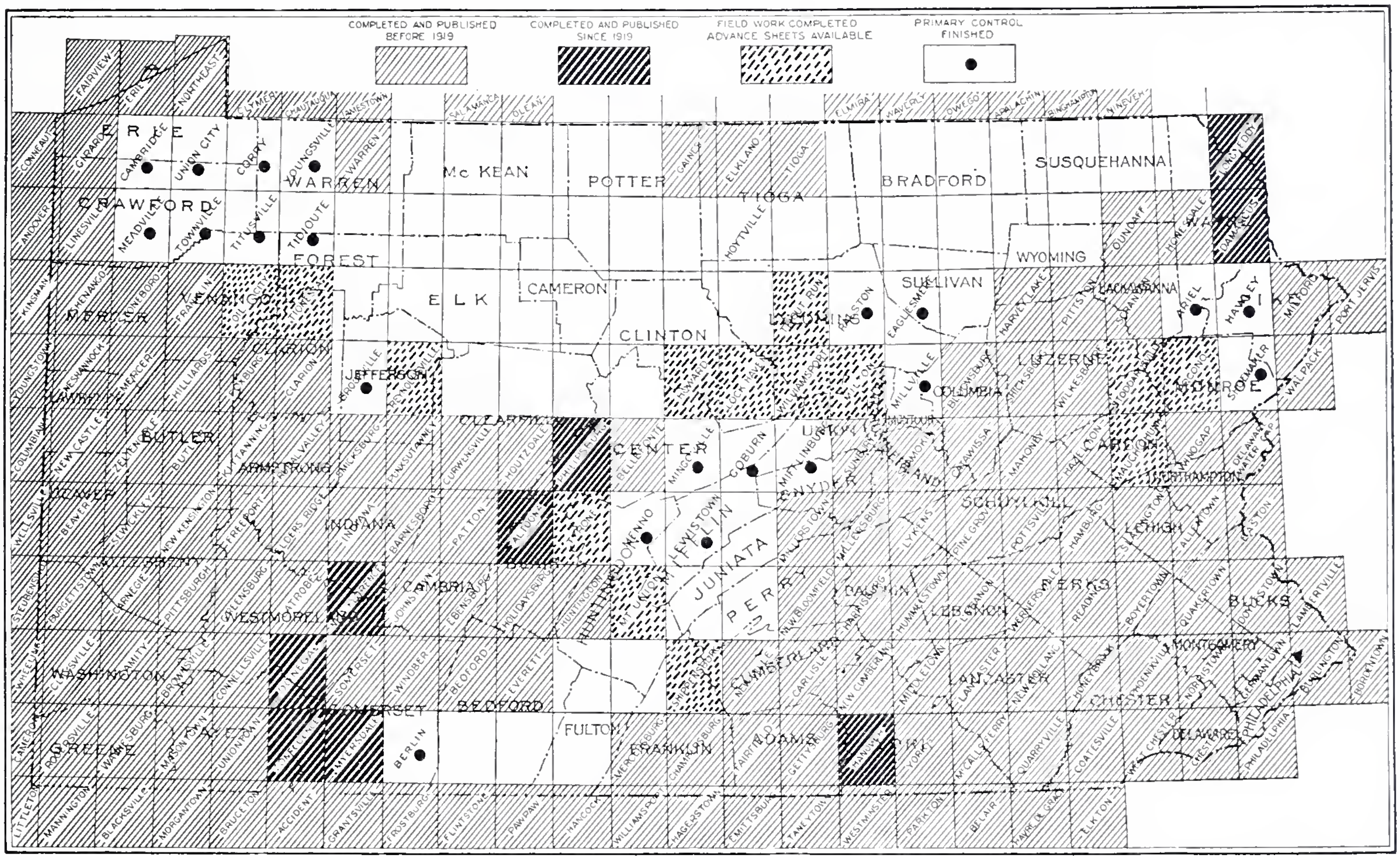

Chart showing progress of topographic mapping in Pennsylvania.

Topographic Surveys.

The topographic mapping, as already explained, has been done in cooperation with the United States Geological Survey, which does the work, the State Survey paying one-half the cost. In the three years of the present State Survey 23 quadrangles of about 225 square miles each or 5000 square miles have been mapped. The quadrangles are named from some prominent town or other geographical feature.

The following quadrangles have been surveyed during the life of the present Survey: Meyersdale, Confluence, Donegal, New Florence, Altoona, Philipsburg, Tyrone, Mount Union, Shippensburg, Hanover, Howard, Lock Haven, Williamsport, Trout Run, Milton, Pocono, Damascus, Long Eddy, Oil City, Tionesta, Reynoldsville, Mauch Chunk, and Stoddardsville. The Meyersdale, Confluence, Donegal, New Florence, Altoona, Philipsburg, Hanover, Damascus, and Long Eddy maps have been engraved.

In addition to the quadrangles completed, primary control of 21 quadrangles has been finished, including eight in a single block, in Erie, Crawford, Warren, Forest and Venango counties, and also the Towanda quadrangle in Bradford County, the Menno, Lewistown, Mingoville, Coburn and Mifflinburg quadrangles in the center of the State; the Ralston, Eaglesmere and Millville in the north central; the Ariel, Hawley and Shoemaker quadrangles in the northeastern and the Berlin quadrangle in the southern part of the State. The primary control of all the unmapped part of the State will be pushed to completion within the next few years.

During the last three years approximately 7 quadrangles a year have been completed. Sixty-eight quadrangles remain unmapped. At the present rate, these should be completed within 10 years. If larger appropriations become available within that period, the time can be cut correspondingly.

AREAL SURVEYS AND GENERAL STUDIES.

Detailed Surveys. The largest undertaking by the Pennsylvania Geological Survey is the detailed geologic study and mapping of the State. The topographic maps form the base for the detailed geologic mapping. This mapping includes the outcrop of coal beds, limestone beds and other rocks, and the precise location of mineral deposits. It includes a study of each mineral resource to determine its quality and quantity; a study of the succession of rocks and of their structure in order to determine the depth at which any bed may be found. This work is done painstakingly because its value depends on its accuracy. The plane table and stadia are used in areas where extremely detailed work is needed. In this type of mapping a geologist may require a rodman and cover only a few miles daily.

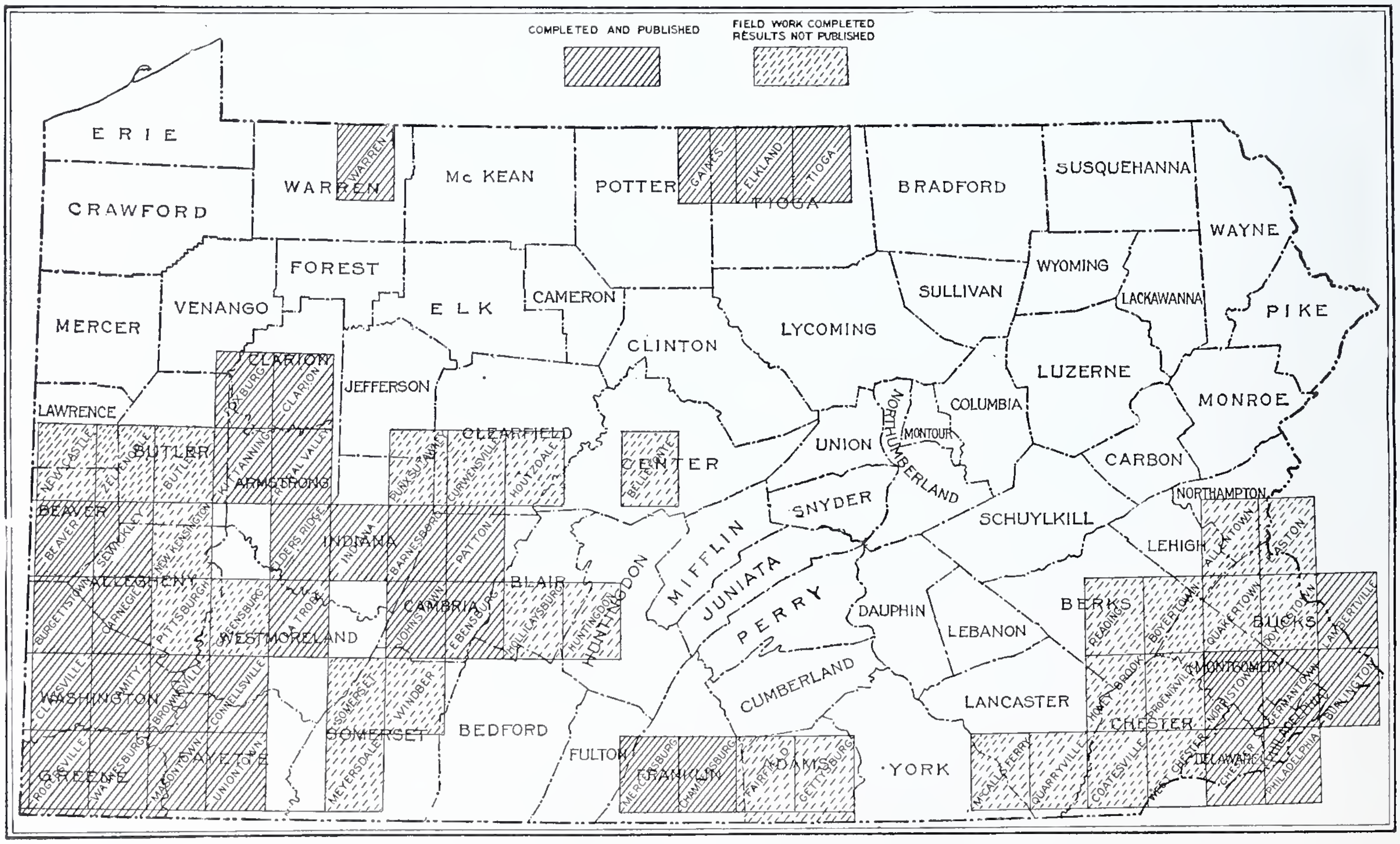

Chart showing progress of geologic mapping in Pennsylvania.

At the time of the organization of the present Survey 27 quadrangles, covering an area of 6075 square miles had been surveyed and published under former cooperative agreements and 8 quadrangles covering 1350 square miles had been completed by the Federal Survey without cooperation. In addition 28 quadrangles covering 6300 square miles had been mapped but not published. Most of the unpublished work was non-cooperative. Total area mapped in detail to date 13,725 square miles or 30.6 per cent. There still remains to be surveyed in detail 31,007 square miles.

From 1919 to 1922 geologic mapping has been done on seven quadrangles, with some additional work in other quadrangles.

Dr. Jonas has been completing the work on the McCall's Ferry and Quarryville quadrangles, including much of the lower gorge of the Susquehanna River and adjacent highlands, the Peach Bottom slate district, and other areas of economic importance.

Mr. Bonine and Mr. Johnson, assisted by Messrs. Bell, Campbell, C. W. Robinson, Graeber, and Schoeneck, have completed the study of the Greensburg quadrangle and nearly completed the survey of the Pittsburgh quadrangle.

The New Kensington quadrangle, which has been studied for several years by the U. S. Geological Survey under the direction of G. B. Richardson, was completed in 1921 in cooperation with the State Survey. Mr. Richardson was assisted by Messrs. Kimball, Faustino, Paxson, and Foley.

The Meyersdale quadrangle is now being mapped by Mr. Sisler, but another season will be required for its completion.

The Reading quadrangle had been studied by the U. S. Geological Survey, but the State cooperated in its completion. The final work was done by Dr. Wherry.

Professor Bissell has been making a detailed study of the New Cumberland quadrangle with special references to the Triassic or "Red beds" which cover most of that area.

Professor Peck spent one season studying oil and gas development in the New Castle quadrangle. This quadrangle had been mapped by the U. S. Geological Survey many years ago, but the report had neither been completed nor published . A large number of oil and gas wells had been drilled since the original survey, and it was desirable to bring the work up to date by inserting results of new developments.

The Federal Survey has had work in progress on several quadrangles in the last decade. This work was under the direction of Mr. Stose of the U. S. Geological Survey, Dr. Bascom, Dr. Miller and Dr. Moore. A number of quadrangles have been completely surveyed, and some are now in process of publication.

Continued cooperation with the Federal Survey in the cost of these detailed studies is planned, and this work will be completed as fast as funds will permit.

County Reports. As detailed data become available and funds warrant, the Survey plans to prepare reports on each county. The Adams County report is nearly completed. Mr. Stose of the U. S. Geological Survey has done the geologic mapping, partly at the expense of the State Survey, and the U. S. Bureau of Soils and the Department of Soils of State College cooperated in a study of the soils to form a chapter in the report. Likewise soil surveys have been made for a report on Greene County.

General Studies. The State Geologist and his assistants have made reconnaissance trips over many parts of the State with which they had not been familiar, to obtain first hand information regarding those areas. These reconnaissance studies will be continued until the Survey geologists are intimately familiar with the general features of every part of the State.

A new geological map of the State was begun but as many changes have been made in the determination of the age of rocks, and some questions of correlation still remain unsettled, the map has been laid aside until further studies could be made. Several of these were undertaken during the season of 1921.

The ridge extending from Franklin County to the Delaware Water Gap, and known as the North or Blue Mountain or Kittatinny Range, was studied to determine if the rock making that mountain was of the same age throughout, or, as had been suspected, changed to a younger rock in going from west to east. This work was undertaken by Professor Eaton.

The State Geologist concluded several years ago that the base of the Allegheny formation as mapped in the Allegheny Valley was not in the same stratigraphic position as mapped in the Beaver River Valley. A study of this problem, including detailed tracing of beds, was undertaken by Mr. Renick.

The rocks in the southeastern part of the State have presented a difficult geologic problem which has been studied by the United States and Maryland Geological Surveys for many years. The rocks are much alike, almost barren of fossils, and have been metamorphosed by pressure and heat until their original character has been completely changed or lost. During the last three years the Pennsylvania Survey has contributed toward a general study of that problem by Dr. Florence Bascom, Dr. Anna I. Jonas, and Dr. Eleanora B. Knopf. The work in 1922 is believed to have definitely settled the stratigraphic relations of the rocks in that area.

During the last three years a number of incidental studies have been made in connection with the supposed discovery of mineral deposits. Many visits have been made to fields where oil and gas have been found in wild-catting, and to regions thought to contain oil and gas, but where the geological conditions were unfavorable. Trips were made to reported potash deposits, and to deposits of kaolin, feldspar, chromite and other minerals to observe the present condition of the industries.

In addition to these field studies, the State Geologist has made a number of fundamental studies, the result of which will be used in the work and publications of the Survey. These have included: (1) A new classification of coal, begun before the State Geologist assumed the office, has been completed and printed in several technical journals. This study was induced by the many attempts to classify coals by their character and quality as a basis for pooling their distribution during the war. (2) A new method of naming coal beds and other rocks in the coal measures, so that the hundreds of names could be replaced by a smaller number in a recognizable sequence. (3) The preparation of a standard geologic time scale for all of the Survey reports. Here, as elsewhere, simplicity consistent with scientific accuracy has been sought. These studies involved many months of work, but were essential if all publications of this Survey are to agree.

MINERAL RESOURCES SURVEYS.

Fuels.

Coal: Detailed mapping of coal-bearing areas in the western part of the State has been referred to under Areal Surveys. A reconnaissance of all the bituminous coal mining districts of the State was made by Mr. Sisler in 1921. An extensive coal sampling campaign has been completed, in which Mr. Woodworth took 486 samples in 175 mines; Mr. Hill took 254 samples in 84 mines; and Mr. Sisler in his work on the Meyersdale quadrangle in 1922 took 15 samples in 12 mines, or a total of 271 mines sampled and 755 samples cut. The analyses of these samples were made by the U. S. Bureau of Mines under cooperative agreement with the Survey.

The reserves of bituminous coal were computed by Mr. Reese and published in 10 county reports and one summary report. Data given includes estimates by townships of original deposit, quantity mined out, and coal recoverable from each mineable bed. The original deposit is estimated at 75,259,000,000 short tons and recoverable coal still in the ground at 43,830,000,000 short tons.

Oil and Gas. Studies in oil and gas have included: (1) A reconnaissance of the oil and gas fields in 1920 by Mr. Robinson, preparatory to writing the introductory report on the Oil and Gas Fields of the State. (2) A detailed study of the oil and gas resources of certain quadrangles in western Pennsylvania. (3) An extensive study of oil resources from bituminous shales and coals of the State by Mr. Fettke. The Carnegie Laboratory at the Carnegie School of Technology, in large measure already equipped for such a study, was used.

During the fall and winter of 1919-20 the Survey gave much time to the gas development at McKeesport and kept daily records of new wells as they were located and drilled in. This information formed the basis for the predictions made that the pool would be short-lived, and that money expended after the first of January, 1920, was not likely to be returned.

Non-Metals.

Clay and Clay Products. Professor Moore began a study of fire-clays before his resignation from State College in 1922. As soon as funds warrant, the study of clays will be renewed.

Sand and Sandstone. Dr. Moore and Mr. Taylor have made an important comprehensive study of the ganister deposits. Ganister supplies the material for making silica brick, one of the State's large industries.

Incidental studies have been made on the flagstones of the northern part of the State. In the fall of 1919 sandstone suitable for use in the proposed memorial bridge at Harrisburg was sought and a deposit in Greene County gave promise of serving if sandstone had been selected. Studies were made of possible sources of vein quartz to be used in facing the bridge had concrete been specified.

Limestone. A preliminary study of Pennsylvania limestones was in progress during 1921-22 by Professor B. L. Miller, assisted by Messrs. Lawall and Fisher. Special attention was given to the possible occurrence of marble in the York Valley, and deposits were found that give promise of a high grade marble.

Igneous and Metamorphic Rocks. Incidental studies have been made in the location of trap dikes as a source of road material for the State Highway Department.

Non-metallic Minerals. Little study has been done on non-metallic minerals. Several localities were visited in which minerals of this group were reported of supposed economic importance. Mineral pigments are an important resource of this group now under development. The supply of the report by the preceding Commission Survey on mineral pigments has long been exhausted, and a new report based on further field study is contemplated.

Metals.

Iron. Mr. Corbin, assisted by Mr. Howell, made a reconnaissance study of the iron resources of the State in 1921. In 1922 a more detailed study of the bog iron deposits of the State was made by Mr. Corbin, as bog iron finds a present day market, being used for the purification of illuminating gas.

It is probable that there exists within the State deposits of magnetite (magnetic iron ore), chromite, and some other metallic minerals, the locations of which are at present unknown. The problem of locating some of these deposits by an extensive magnetic survey over geologically favorable areas was considered, a small amount of preliminary field work was accomplished, and some preliminary magnetic measurements were made.

Non-ferrous Metals. No extensive study was made on this group of metals, though it is hoped that studies will be started in the near future on our copper, lead, and zinc deposits, in particular, to learn if they have any commercial value and may be counted upon as a source of future industry.

Soils.

The soils of Adams and Greene counties were the subject of study in 1921 by Messrs. Patrick, Merkle and Zierdt. As previously stated, this was a cooperative study with the U. S. Bureau of Soils and the Department of Soils of State College. The chapters on soils to be included in the reports of Adams and Greene counties have been prepared.

Water Resources.

The underground water resources of the State have been the subject of many inquiries and have led to a number of special field trips. Four of these studies in cooperation with municipalities have already been referred to.

Work To Be Done.

From the above brief statement it is apparent that good progress has been made toward the completion of the topographic mapping; and a start has been made on the detailed geologic mapping. The geologic mapping has lagged far behind the topographic mapping and will require many years longer to complete. There is a strong popular demand for geological reports put up by county units. There are sixty-seven counties. Funds have not warranted undertaking more than one of these county reports, that of Adams County. The preparation of geologic guide books of areas traversed by our railroads and fine highways and of popular educational texts on the geology and resources of the State is a broad field not yet entered.

The introductory reports on the oil and gas fields, the bituminous coal fields, the iron ores, and the limestones of the State must be followed by detailed reports by districts, the district reports as a rule containing more details and involving vastly more work than the introductory reports. With a production of over fifty million dollars worth of clay products in Pennsylvania each year, there is a strong demand for information on the clays of the State. This is a large subject and will require much work to cover adequately. The only member of the sandstone group of resources yet touched is ganister. The other phases of our sandstone resources will be taken up in turn. The ganister report is intended to be final, as is also the report on the oil shales of the State. Slate, granite, feldspar, and graphite are among many other resources awaiting the completion of work in hand or the appropriation of more funds before they can be considered.